Journal of Forensic and Legal Medicine 24 (2014) 24–27

Contents lists available at ScienceDirect

Journal of Forensic and Legal Medicine

journal homepage: www.elsevier.com/locate/jflm

Original communication

The chronological age estimation of third molar mineralization of Han population in southwestern China

Maofeng Qing [a,*], Lihua Qiu [b], Zhi Gao [c], Kishor Bhandari [d]

[a] Stomatology Department, Fuling Center Hospital of Chongqing City, China
[b] The Affiliated Hospital of Stomatology, Chongqing Medical University, China
[c] Stomatology Department of the Second Affiliated Hospital of ChongQing Medical, China
[d] Department of Oral and Maxillofacial Surgery, 2nd Affiliated Hospital of Jiamusi University, China

ARTICLE INFO

Article history:
Received 9 March 2013
Received in revised form
9 February 2014
Accepted 20 March 2014
Available online 28 March 2014

Keywords:
Third molar mineralization
Forensic age estimation
Demirjian's staging method

ABSTRACT

The purpose of the study was to estimate the chronology of third molar mineralization in Han population of southwestern China and find its unique characteristics so that it would provide a reference in several legal cases like forensic age estimation. The study used Demirjian's staging method to study 2192 orthopantomograms of 984 male and 1208 female subjects aged between 8 and 25 years. The statistical data was analyzed by Student's *t* test and ANOVA.

The conclusions of the study are: (1) The chronological mineralization age of third molars of Han population in Southwestern China is similar to the Turkish and the Japanese, was earlier than the Austrian and Han of South China, but later than the Spanish. (2) The mineralization timing of the third molars between two sides in maxilla or mandible has no significant differences in the same gender group. (3) There is no significant difference in mineralization of third molars between male and female, except for tooth 48 in Demirjian's stage E. (4) The mineralization of third molar in maxilla is earlier than mandible.

1. Introduction

In recent years, applications of forensic age assessments have increased rapidly in various aspects of forensic medicine.[1] Some examples include estimating the age of unknown victims, determining the right or obligation of society, explicit the penalty of criminal liability and assess the age of immigrants when they are unable to produce valid identity documents proving their real age.

14, 16, 18 and especially 18 are important ages in Chinese law for the juveniles. So, age estimation in this age group holds a significant importance in different legal cases. The methods of chronologic age estimation include a physical examination for sexual maturity, hand-wrist X-ray examination, radiographic or CT examination of clavicular epiphyseal cartilage, and dental examination.[2] The drawback of estimating epiphysis-diaphysis ossification in hand and wrist is that the process is completed around the age of 18 which is quite earlier as compared with third molar development that continues until the early twenties. Moreover, towards the end of human skeletal growth and development, only a few age-dependent features can be evaluated by morphological methods. On this context, the third molar, the last tooth to initiate and complete development is the last available dental morphologic predictor of age.[3]

The initiation, development and eruption of third molar occur after birth, and are closely related with age. Historically, the third molar was called as 'wisdom tooth' because the eruption time of the third molar usually coincided with the mental maturity, nearly around 18 years of age. Presently, individual chronological age is determined by observing the development and maturity of crown and root of the third molar through orthopantomograms.

Several methods have been described for the determination of dental development status from radiographs.[4–7] Most of these are based on a comparison of the radiographic image of development of teeth with standard charts compiled from a large number of persons, usually in a well-defined geographic region.[2] One widely used method is the one first described by Demirjian et al., in 1973 based on a large number of French–Canadian children.[4] The method evaluates the development of seven mandibular teeth from a panoramic radiograph and calculates dental age.[8]

* Corresponding author. Stomatology Department, Fuling Center Hospital of Chongqing City, 76 Linjiang Road, Chongqing, China. Tel.: +86 13658438415.
E-mail addresses: doudouwq23@gmail.com (M. Qing), gqyidi2001@yahoo.com.cn (L. Qiu), drkishorb@gmail.com (K. Bhandari).

http://dx.doi.org/10.1016/j.jflm.2014.03.004
1752-928X/

In any anthropological analysis, the characteristics of reference population are significant. Influence of genetic, nutritional and geographical factors must be taken into account in benchmarking the development. So, cross-applicability of standards for members of different ethnic groups has been the subject of much discussion.[9] Until now, several studies have been undertaken in different populations and regions to explore the usefulness of the third molar as a reliable age indicator.[10–13] China is vast in territory, and Han is the largest population in the world. Therefore, to estimate the age by evaluating the radiographic features of third molar mineralization in young Han population of a designated area would be very meaningful for forensic age estimation.

In this study, our objective was to evaluate dental development in a sample of adolescents and young adults of southwestern China, make a comparison with previous studies on other ethnic groups or geographical area and try to find any significant trend.

2. Materials and methods

The sample consisted of 2192 conventional individual orthopantomograms from southwestern China taken at the Affiliated Hospital of Stomatology of Chongqing Medical University between the year 2008 and 2011. Individuals' age and sex were recorded and all of them belonged to Han ethnic group in southwestern China, were in good health without any chronic diseases and genetic diseases and without any features of malnutrition. Moreover, none of the third molars were absent in these individuals. All of the orthopantomograms were clearly observed and properly studied by experts in the field. The data set included 1208 females and 984 males and was collected from the individuals ranging from age of 8–25 years. The age and sex distribution of the study population is shown in Table 1.

The development and mineralization of third molars was recorded by Demirjian's method.[4] The method includes description of eight stages (A–H), the first four stages (A–D) comprising crown formation from the beginning of cusp calcification to the crown completion, and the second four stages (E–H) comprising root formation starting from initial radicular bifurcation to apical closure.

The mineralization stages were evaluated by two radiologists; 1100 cases by the first and 1092 cases by the second. The method used to test the assessments consistency of dental development stage between the two radiologists and the reproducibility of the same radiologist was as follows: first, 250 orthopantomograms were randomly selected and evaluated by both the radiologists. Four weeks after the first evaluation, these orthopantomograms were re-evaluated by both radiologists again. Finally, Wilcoxon matched-pairs signed-rank tests were performed to analyze the evaluation results.

The timings of the third molars mineralization were recorded and data analyzed using Statistical Package for the Social Science (SPSS) for windows, Version 13.1 and Microsoft Excel 2003 for Windows. Descriptive statistics was obtained by calculating the mean, standard deviation, and range of the chronological ages for the eight stages of dental development. The difference of two genders was analyzed using Student's *t* test.

Table 2
Statistic data of chronological mineralization of third molars.

Tooth	Stage	Males			Females			*p*
		Number	Mean	S.D.	Number	Mean	S.D.	
18	A	30	10.47	1.36	36	10.11	1.88	0.533
	B	148	11.46	1.5	130	11.74	1.19	0.231
	C	164	12.78	1.26	176	12.473	1.43	0.094
	D	164	13.77	1.59	190	13.65	1.73	0.646
	E	132	15.17	1.73	146	15.11	2.15	0.864
	F	42	16.1	1.81	92	16.89	1.92	0.116
	G	46	18.04	2.08	76	18.13	1.44	0.846
	H	258	21.42	2.64	362	21.45	2.41	0.92
28	A	28	10.29	1.38	38	9.79	1.58	0.356
	B	134	11.39	1.48	102	11.78	1.17	0.118
	C	182	12.68	1.25	214	12.45	1.37	0.216
	D	174	13.86	1.53	194	13.69	1.65	0.467
	E	120	15.3	1.78	144	15.44	2.31	0.693
	F	48	16.17	1.79	84	16.98	2.01	0.106
	G	42	18.14	2.06	70	18.31	1.55	0.725
	H	256	21.45	2.64	362	21.4	2.45	0.886
38	A	64	10.63	1.56	54	10.44	1.7	0.672
	B	158	11.97	1.4	178	11.94	1.17	0.876
	C	224	13.14	1.36	260	13.03	1.56	0.554
	D	114	14.3	1.75	116	14.81	1.89	0.131
	E	114	15.82	1.84	150	16.32	2.31	0.186
	F	36	16.83	1.69	58	17.17	1.54	0.483
	G	50	18.64	1.58	92	19.2	1.85	0.207
	H	224	21.92	2.4	300	21.89	2.24	0.927
48	A	54	10.67	1.776	60	10.5	1.61	0.712
	B	192	11.86	1.295	166	11.95	1.18	0.64
	C	224	13.35	1.367	272	13.04	1.62	0.108
	D	92	14.41	1.707	128	14.84	1.65	0.187
	E	106	15.74	1.831	126	16.54	2.35	0.045*
	F	46	17.39	1.751	72	17.33	1.72	0.901
	G	42	18.43	1.535	90	19.31	1.83	0.06
	H	228	21.87	2.419	294	21.92	2.25	0.863

*$p < 0.05$.

3. Results

The mean mineralization ages for various stages of third molar mineralization with their standard deviations and standard error are described in Table 2.

Firstly, the difference of chronological age between all the four third molars were tested using the Student's *t* test and was found that only 48 in the stage E had significant difference in mineralization between male and female ($p = 0.045$). The comparison of mineralization of third molars with reference to gender group is described in Table 3.

There was significant difference in mineralization ages between maxilla and mandible in between males and females. For males, at stage B, mineralization of 18 was 0.51 years earlier than 38, that of 28 was 0.58 years earlier than 38 and 0.47 years earlier than 48. At stage C, mineralization of 18 was 0.57 years earlier than 48, that of 28 was 0.46 years earlier than 38 and 0.67 years earlier than 48. Lastly, the mineralization of 18 and 28 in stage F were earlier than 48 by 0.73 years and 1.29 years respectively.

For females, at stage C, D, E and G development of 18 and 28 were all earlier than 38 and 48 and the difference was significant. At stage C, development of 18 was 0.557 years earlier than 38, and

Table 1
Number of individuals per age group and sex.

	Age (years)																		Total (*n*)
	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Male	8	18	26	70	138	116	132	74	64	50	44	42	38	34	28	22	40	40	984
Female	8	14	24	86	164	154	80	74	96	72	56	74	68	44	54	52	44	44	1208
Total	16	32	50	156	302	270	212	148	160	122	100	116	106	78	82	74	84	84	2192

Table 3
Statistic data of chronological mineralization of different gender.

Gender	Tooth	Stage							
		A	B	C	D	E	F	G	H
Male	18	10.47 ± 1.36	11.46 ± 1.50	12.78 ± 1.26	13.77 ± 1.59	15.17 ± 1.73	16.10 ± 1.81	18.04 ± 2.08	21.42 ± 2.64
	28	10.29 ± 1.38	11.39 ± 1.48	12.68 ± 1.25	13.86 ± 1.53	15.3 ± 1.78	16.17 ± 1.79	18.14 ± 2.06	21.45 ± 2.64
	38	10.63 ± 1.56	11.97 ± 1.40	13.14 ± 1.36	14.30 ± 1.75	15.82 ± 1.84	16.83 ± 1.69	18.64 ± 1.58	21.92 ± 2.40
	48	10.67 ± 1.78	11.86 ± 1.30	13.35 ± 1.37	14.41 ± 1.71	15.74 ± 1.83	17.39 ± 1.75	18.43 ± 1.54	21.87 ± 2.42
	F	0.219	3.25	5.559	2.283	1.932	2.702	0.523	1.342
	p	0.883	0.022	0.001	0.07	0.125	0.051	0.668	0.26
Female	18	10.11 ± 1.88	11.74 ± 1.19	12.43 ± 1.43	13.65 ± 1.73	15.11 ± 2.15	16.89 ± 1.94	18.13 ± 1.44	21.45 ± 2.41
	28	9.79 ± 1.58	11.78 ± 1.17	12.45 ± 1.37	13.69 ± 1.65	15.44 ± 2.31	16.98 ± 2.01	18.31 ± 1.55	21.40 ± 2.45
	38	10.44 ± 1.70	11.94 ± 1.17	13.03 ± 1.56	14.81 ± 1.86	16.32 ± 2.31	17.17 ± 1.54	19.20 ± 1.85	21.89 ± 2.24
	48	10.5 ± 1.61	11.95 ± 1.18	13.04 ± 1.62	14.84 ± 1.65	16.54 ± 2.35	17.33 ± 1.72	19.31 ± 1.83	21.92 ± 2.25
	F	0.852	0.61	5.779	11.312	6.311	0.457	5.136	2.29
	p	0.469	0.609	0.001	<0.001	<0.001	0.712	0.002	0.077

0.567 years earlier than 48 and that of 28 was 0.58 years earlier than 38 and 0.59 years earlier than 48. At stage D, mineralization of 18 was 1.16 years earlier than 38, and 1.19 years earlier than 48. Similarly, the mineralization of 28 was 1.12 years earlier than 38 and 1.15 years earlier than 48. At stage E, 18 developed 1.21 years earlier than 38, and 1.43 years earlier than 48. 28 completed the mineralization 0.88 years earlier than 38 and 1.1 years earlier than 48. At stage G, mineralization of 18 was 1.07 years earlier than 38, and 1.18 years earlier than 48. 28 developed 0.89 years earlier than 38 and 1.0 years earlier than 48.

In addition, at stage H, 18 and 28 developed earlier than 38 and 48 and the difference was significant. Similarly, the mineralization of 18 was 0.46 years earlier than 38, and 0.45 years earlier than 48. Lastly, 28 completed the development 0.48 years than 38 and 0.47 years than 48.

4. Discussion

Human teeth are one of the markers of growth and development. With differences in ethnicity, living environment and habits, the timings of tooth development and eruption are different. And moreover, the differences between countries or other geographical areas are not constant over age and vary in an unordered way.[10] So, a lot of researches have been done to find the correlation between development of teeth and biological age for different races and regions.[10–13]

Many methods have been proposed to record the development of third molars and correlate it with biological age such as Moorrees,[5] Demirjian,[4] Haavikko,[6] Solari[7] and others. Demirjian et al. clearly distinguished the mineralization stages of tooth crown and root by definite timings into eight stages, namely A–H. It is a simple, convenient and reproducible method and shows very good intra- and inter-examiner agreement.[17] So, this method was preferred in assessing third molar development in our study.

A. Meinl et al.[1] analyzed the development of mandibular third molars form 610 orthopantomograms of Austrian adolescents and young adults between age 12 and 24. In comparison with our study, development of third molars in Austrian male was later than Han population of southwestern China except stage E. In stage H, development of 38 was 0.48 years later and that of 48 was 0.63 years later. In Austrian females, all the stages were later. Especially in stage H, development of 38 was 1.01 years later and 48 was 0.88 years later than the Han of southwestern China.

Prieto et al.[9] studied third molar development of 1054 Spanish population. In comparison to this study, mandibular third molars in stage C and D developed later than Han males of southwestern China but earlier in stages E, F, G, and H. Specifically in the stage H, 38 developed 2.18 years earlier and 48 developed 2.67 years earlier. The result was same for the females too and in stage H, 38 developed 2.23 years earlier and 48 developed 2.32 years earlier.

Sisman et al.[14] analyzed third molar development of 900 Turkish children and young adults. They found significant differences in third molar development between male and female in the calcification stages D and G. In our study, only the stage E had significant differences between male and female. In comparison to Han of southwestern China, the developmental stages in Turkish males were approximately similar in all stages. In Turkish females, the development was approximately similar in the early and middle stages, but in the stage G and H, they completed the development of third molars after 1.16 and 1.21 years respectively.

Arany S. et al.[15] analyzed third molars of 1282 Japanese juveniles by orthopantomograms. In comparison to this study, in stage C, D, E and F, Japanese Juveniles obviously completed the development of third molars later than Han of Southwestern China. But in the stages G and H, there was no significant difference.

Dong Lin Zeng et al.[16] analyzed the development of maxillary and mandibular third molars from 3100 orthopantomograms of Han in southern China i.e. in the same country and the same ethnic group. The result showed similar mineralization time for the stage A, B, C, D and E in all the third molars. However, the chronological mineralization age of Han of southwestern China in 38 and 48 was 0.23–1.53 years earlier than that of Han of southern China during stages F to H. In maxillary third molars, the time was 1.3–2.71 years earlier.

Many authors[18–21] have concluded that the root growth in third molars in the upper jaw completed earlier than the lower jaw. The result was same in our study and it showed the same trend of an earlier third molar development in upper jaw bilaterally compared to the lower jaw. But, the results of our study was quite different with the previous studies of Han population in other areas of China.[16,22]

From the comparison with others races and countries, we found that the chronological mineralization age of third molar of Han population in Southwestern China was similar to that of Turkish and Japanese, was earlier than Austrian and Han of South China, but later than Spanish. Moreover, symmetrical third molar mineralization was found in left and right sides of the defined population and in the same gender group, no significant differences was observed between the left and right sides.

5. Conclusion

In this study, we analyzed the chronological development of third molars of Han population in Southwestern China, and found that the population had its own characteristics as follows:

(1) The mineralization ages between two sides in maxilla or mandible have no significant difference in the same gender group.
(2) There is no significant difference in mineralization of third molars between males and females, except 48 in stage E.
(3) The mineralization of third molar in maxilla is earlier than mandible.

Ethical approval
None.

Funding
None.

Conflict of interest
None declared.

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